

theodolite, and as full instructions are given about one as about the other.

It is quite refreshing to read the chapter "Indications pour faire un levé de Terrain à la Boussole," and then the instructions given relating to subsequent work with the large-scale maps published by the French Government.

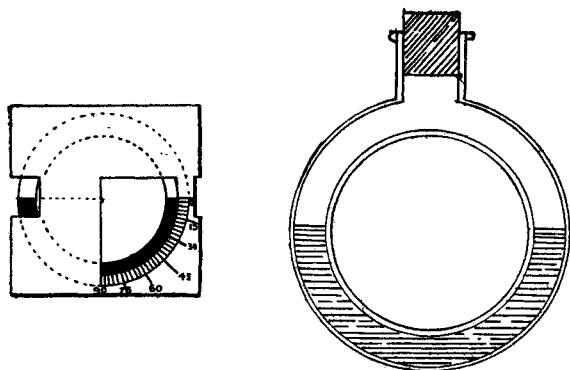


FIG. 6.—Details of the water-level clinometer.

For the angular measurement of elevation, including, therefore, the angular height of the horizon as seen from any monument, the archæologist is recommended to use a very simple and convenient addition to the compass devised by M. Hue. The method employed can be readily gathered from the accompanying woodcuts, obligingly sent to me by the publishers of the "Manual."

It would be a good thing if some one of our many archæological societies would prepare an edition of this excellent French manual for the use of British workers.

NORMAN LOCKYER.

PLAGUE AND FLEAS.

IT is a matter of dispute as to where in ancient literature the first definite mention of rats and plague is to be found, and where such mention does occur it is again uncertain what the author intended to convey. It can hardly be doubted, however, that Avicenna, who flourished about the year 1000, clearly refers to this relationship when he says, "Et de eis quae significant illud (the approach of plague) est ut videas mures et animalia quae habitant sub terra fugere ad superficiem terrae et 'pate sedar' id est commoveri hinc inde sicut ebria."

It is noteworthy, however, that Avicenna does not state that the rats died. Passing over many other records of more or less definiteness we come to the important statement of the Byzantine historian Nicephorus Gregoras, who wrote of the plague in Constantinople in 1347, "Nec vero homines solos morbus ille usque flagellabat; sed et si quae alia animalia cum hominibus plerumque degerent et habitarent; canes inquam et equos et cujusque modi avium genera; ipsos etiam mures, si qui forte in domorum parietibus latitabant." Orreaus also, in the plague of Moscow in 1771, mentions rats, but no special stress is laid on the fact, and other animals, as by many other authors, are included. He says, "De avibus a plurimis narrabatur quod minores cantatrices caveis detentae in domibus infectis emorerentur, immo quod mures et glires quantumvis antea copiosi disparuerint; sed de his fides apud relatores esto."

In modern times the death of rats during or before epidemics of human plague was first noticed in India, viz. in Kumaon, 1833-35, by Gowan, in the Pali

plague; 1836-8, by Forbes White; and in Kumaon, 1853, by Francis and Planck. Renny states that during the epidemic of 1851 in Kumaon, in two huts occupied by sixteen men (twelve of whom died of plague) a large number of dead rats was found, but that the cattle, thirty in number, escaped. Rocher, in 1878, in Gun-nam, Baker and Lovry in China, state that the rats were first attacked. Yersin, studying the great epidemic of 1894 in China, states that the rats found dead contained the plague bacillus in abundance, and many of them presented true buboes. Many other observations of a similar kind might be quoted. Not always, however, is the relationship manifest, for Hankin states that despite the most careful inquiries no evidence could be obtained of the existence of an outbreak among rats during or after the outbreak among human beings in Hurdwar. Nor, again, in the epidemic of Glasgow could the relationship be established, though it was proved in the outbreak in 1901-2. Further research will show whether these exceptions are real, or due to insufficient observation.

Not only rats, but other animals have in recent years been found to suffer from plague. Thus there exists in Mongolia a peculiar form of plague known as *targagan* plague. The *targagan* is a marmot-like rodent (*Artomys bobac*).

Almost every year an epidemic disease breaks out among these marmots, and a marmot that is affected always dies. The natives of the Baikal districts avoid handling any animal that has axillary and inguinal buboes, though dogs and wolves are said to eat them with impunity. In the skinning and handling of these marmots the peasants contract the disease, and epidemics of this origin are reported throughout the whole of the east Asiatic plateau of Siberia and Mongolia to Tibet. The disease is almost undoubtedly plague, though bacteriological proof is not yet forthcoming.

It has been noted, further, that palm squirrels (*Sciurus palmarum*) die of plague in great numbers in certain parts of India. Further, among the Carnivora, dogs and cats may develop plague. In certain parts of India cats have been found in abundance with suppurating buboes in the neck, the position of the bubo, it is interesting to note, suggesting its origin in ingested food (rats). Finally, monkeys have died of plague in several places in India.

Rats and Fleas.—Ogata, in 1897, succeeded in giving a mouse plague by means of bacilli got from fleas taken from rats dead of plague. Simond, in 1898, attributed the infection of man to the fleas which had left the bodies of rats dead from plague.

"It is usually in the morning that the carcass of a rat which has died in the night is fatal to him who touches it. We were unable to discover a single case of a rat whose death had occurred twenty-four hours previously having communicated the plague. Simond also made the following experiment. He placed twenty fleas (obtained from a cat) in a bell jar, with a rat dying of plague. He then placed a healthy rat in a cage into the bell jar, but also allowed the cadaver of the first rat to remain thirty-six hours in the vessel. The second rat died on the fifth day of plague. The experiment was repeated, but not always with success" (Quoted from Nuttall, "Insects, Arachnids, and Myriapods as Carriers of Bacterial and Parasitic Diseases," pp. 9-20).

Simond believed that infection from man to man takes places, but in an insignificant number of cases as compared to those where fleas carry the infection from rat to man. He regards rats as the main cause in the spread of plague among human subjects.

Loir affirmed that the fleas of rats are the main

agents through which the disease is transmitted to man. Kolle and Nuttall, however, obtained negative results in this direction. The Indian Plague Commission (1899) came to the conclusion that Simond's proposition that suctorial insects play an important part in the transmission of plague from sick to healthy animals is so weak as to be hardly deserving of consideration.

In 1902 Gauthier and Raybaud, at Marseilles, carried out further experiments, and got positive results.

"Recueillant en bloc un certain nombre de puces sur des rats capturés sains, nous avons parasité artificiellement à leur asile des animaux de laboratoire préalablement inoculés de cultures pures. Nous avons cherché ensuite à produire infestation parasitaire et l'infection consécutive d'animaux neufs. Les résultats absolument concordants de cette série d'expériences (five experiments) nous permettent de conclure que les puces des rats sont capables d'une façon constante de transmettre la peste d'animal à animal rat ou souris."

Further, they showed that rat fleas could bite man.

Ashburton Thompson, studying the plague epidemics in Sydney from the epidemiological standpoint, came to the conclusion that Simond's hypothesis of the flea best explains the phenomena of the epidemic plague as seen at Sydney. He further states that the laboratory proof has been given by Raybaud and Gauthier, and by Dr. J. S. C. Elkington at Bombay, "whose observations are affirmatory of Simond's original experiments made in India."

Elkington¹ describes his own results in the following words:—"The technical difficulties were considerable . . . and a great deal of experiment was required before a satisfactory means was obtained of insuring the captivity of such a small and active insect whilst feeding. This was finally effected by confining them in a test tube of which the mouth was covered with very fine gauze through which the insect could thrust its proboscis when the gauze was applied to the skin of the feeder-animal. Fleas were then fed on experimentally infected rats. . . . The fleas were then kept in a dark drawer still in the feeding tube for varying periods, after which they were again fed on healthy young rats selected for their vigour and health. The results were most successful, and I have records of four instances in which I was able to carry out this method of infection. Captain Liston also was successful in several cases. Attempts were then made to convey the disease from human beings to rats. Two instances were successful, the period from the first feeding being eight hours. . . . Both rats died of plague, one on the fourth, the other on the sixth day."

Much attention was now given to the question as to what species of fleas those found on rats belong.

Tidswell, in 1903, working at Sydney, found that 81 per cent. of the fleas on rats were *P. pallidus* (i.e. *P. cheopis*). Tiraboschi found that 40 per cent. of fleas on ship rats belonged to the same species. Liston, 1905, found that while other species were found on European rats in India, 99 per cent. of the fleas were *P. cheopis*. Though unable himself to get positive results in the transmission, yet he says, "To sum up, then, rat fleas (*P. cheopis*) can always be found in (plague) infected houses; these fleas will take to an animal which is not their normal host." Finally we have the experiments of the Plague Commission of 1905 working in Bombay. These elaborate and very carefully conducted experiments have

conclusively established the fact of the conveyance of plague from the infected to the healthy rat by means of the plague flea. We still require light on the exact method by which the bacilli are conveyed; why so many other investigators have failed in similar experiments, and whether rats transmit the disease in any other way, and, indeed, whether this is the most important way. In discoveries of this kind we are apt to give the credit at the time to the person who forges the last link of the chain which stretches across the gap of unknown causes. Credit is, however, also due to those who forge the intermediate links; indeed, perhaps most of all to him who forged the first link, without which the chain would not have been begun.

J. W. W. S.

Literature.

Consult especially:—

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THE INTERNATIONAL ASSOCIATION OF SEISMOLOGY.

THE first general meeting of the International

Association of Seismology was held at The Hague on September 24 and 25, and was preceded on September 21 and 23 by a meeting of the permanent committee, which is the body charged with carrying out the decisions of the general assembly.

The following countries (in alphabetical order according to their French names) now form part of the association:—Germany, Austria, Belgium, Bulgaria, Canada, Chili, Congo, Spain, United States, Great Britain, Greece, Hungary, Japan, Italy, Mexico, Norway, the Colonies of the Netherlands, Portugal, Roumania, Russia, Servia, and Switzerland. It was understood that the French Government was prepared to join, but as the necessary money grant had not been submitted to the Chamber of Deputies, the adhesion has not yet been formally made. Nevertheless, the French delegates were requested to take part in the proceedings on the same footing as those of the other countries.

The budget for the forthcoming year was submitted to the permanent committee, and was carefully discussed. The income of the association is now about 1900l. The secretary, Prof. Kövesligethy, of Budapest, on whom a great part of the labour of the association falls, receives 200l.; 460l. is spent in other salaries, including those of a type-writer, mechanic, and in connection with the Central Bureau at Strassburg; office expenses amount to about 150l.

In addition to the above salaries, two scientific assistants, Mr. Rosenthal, of Pulkowa, and Mr. Oddone, of Rome, were during last year paid out of the funds of the association, and were engaged in preparing separate catalogues of microseismic and macroseismic disturbances. The question how far scientific assistants of this kind should during the next two years be maintained by the association was left to the decision of the executive committee, which

¹ Board of Public Health. Address on Fleas and Plague Convection by Dr. J. S. C. Elkington, delivered before the Victorian Branch of the British Medical Association, July 22, 1903.